Study to Conduct Further Research Regarding the Magnitude of, and Reasons for, Chronically Malfunctioning On-Site Sewage Facility Systems in South Texas

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I. PROJECT HISTORY

In the Spring 2001, Reed, Stowe & Yanke, LLC ("RS&Y") conducted a survey on behalf of the Texas On-Site Wastewater Treatment Research Council ("Council") to determine the magnitude of, and reasons for, chronically malfunctioning on-site sewage facility (OSSF) systems throughout the State of Texas. This project is referred to as Phase I. For the purposes of survey analysis, Texas was divided into five regions based on various soil and climate conditions. The survey results were then analyzed on a regional and statewide basis.

In the original study conducted by RS&Y, the southern region of the State, which includes an area known as the "Valley" (presented as Region III), was determined to have a relatively low survey response rate when compared to response rates from the remaining regions of the State. Region III had a survey response rate of 44% based on the number of surveys completed and returned, and a response rate of 32% based on the number of OSSF systems that were represented by the returned surveys. These rates are significantly lower than the response rates for the State of Texas, were 64% and 75% respectively.

As a result of this lower response rate, RS&Y was retained by the Council in December 2001 to conduct a follow-up survey. The goal of this follow-up survey (Phase II) was to attain additional data regarding the number of chronically malfunctioning OSSF systems in Region III and combine these results with the original survey findings from Phase I.

II. METHODOLOGY

A total of 19 Designated Representatives (DR) in Region III were non-responsive to the original survey. For the Phase II survey, the project team contacted each of the DRs at least four times by telephone in an attempt to perform the follow up survey. The questions that were asked to each responding DR included:

- What is the total number of OSSF systems in your area of jurisdiction?
- In the average year, how many OSSF systems in your area of jurisdiction tend to malfunction chronically?
- What is your source of knowledge? (professional knowledge, files/paperwork, computer database)

The new responses were compiled with the results from the original study in order to determine the number of chronically malfunctioning OSSF systems in Region III. The final results for Region III are presented in Appendix A, and the final results for all other regions of the State are presented in Appendix B.

III. SURVEY RESULTS

A. Survey Response Rate

The project team undertook phone calls to 19 Designated Representatives in Region III. Each DR was phoned at least four times in order to provide ample opportunities for contact with the project team. The project team received a total of 14 responses out of the total 19 contacted, for a Phase II response rate of 73.7%. Unlike the four-page survey distributed in Phase I, the respondents to Phase II were asked to only answer three questions through a telephone interview. However, one DR requested to fill out an entire survey. This DR's survey response is included in the new results for Region III.

The final results of the survey response rate for Region III can be expressed in different ways. A response rate of 47.1% is based on the total number of written surveys completed and returned[1]. An alternative measure of response rate takes into consideration the number of OSSF systems that are within the jurisdiction of the DRs that completed a written survey. Therefore, this measure of response rate takes into consideration the percentage of OSSF systems that are "represented" by the completed surveys. The response rate of 68.6% is for the OSSF systems represented by the completed written surveys.

The next response rates take into consideration the respondents to the Phase II telephone interviews as well as the original written survey results. This cumulative response rate of 85.3% is based on the total number of written surveys completed as well as telephone interviews. The response rate of 95.1% is based on the number of OSSF systems represented by the completed surveys and telephone interviews. Table A illustrates these response rates.

Table A. Region III Response Rate

Region III Data	Frequency	Percentage
Total number of counties in region.	23	
Total number of surveys mailed to Designated Representatives.	34	
Total number of written surveys returned.	16	47.1%
Total number of written surveys and telephone responses.	29	85.3%
Estimated total OSSF systems in Region III from Census data.	138,291	
Response rate based on OSSFs represented by written surveys.	94,921	68.6%
Response rate based on OSSFs represented by written surveys & telephone responses.	131,447	95.1%

B. Chronically Malfunctioning OSSF Systems

The first and second questions asked during the telephone interviews inquired about the total number of OSSF systems within the respondent's jurisdiction and the number of chronically malfunctioning systems in the typical year. The telephone responses to these questions were generally consistent with the rates of malfunction reported in Phase I. Region III continued to

[1] This response rate includes the one survey completed in Phase II.

report a relatively low number of chronically malfunctioning OSSF systems when compared to the other regions of the State.

The respondents in Phase II reported to have a total of approximately 87,302 OSSF systems within their jurisdictions. Of these systems, approximately 4,199 were reported to malfunction chronically, for a malfunction rate of 4.8%. These responses were then combined with the previous responses from Phase I, which reported a 2.8% rate of chronically malfunctioning OSSF systems in Region III. When the two sets of data were combined, the percentage of chronically malfunctioning OSSF systems was reported to be 4.1%. Table B illustrates the rate of chronic malfunctioning OSSF systems for the responding jurisdictions in Region III.

Table B. Chronically Malfunctioning OSSF Systems

Region III Data	OSSFs Represented by Responses	Malfunctioning OSSFs	Percentage
Estimated number of chronically malfunctioning OSSF systems based on survey response data and telephone responses.	131,447	5,446	4.1%

C. Source of Knowledge

The final question asked during the telephone interviews inquired about the source of knowledge used to provide the information in the first two questions. Table C shows the results of the original Phase I responses to this question, the Phase II responses, and the combined responses.

The results of this question reflect results similar to Phase I responses. The number of DRs that utilized a computer database for reference purposes was approximately the same for both phases of the project. The number of DRs that utilized files/paperwork was fewer for Phase II than for Phase I. Overall, it is apparent that the large majority of DRs utilized personal knowledge and files/paperwork to attain historical information regarding malfunctioning OSSF systems in their jurisdiction, and DRs that referenced a computer database were the exception.

Table C. Source of Knowledge

Region III Data	Phase I		Phase II		Phase I & II	
Select all sources of information you used to provide answers for this survey.	Responses	Percentage	Responses	Percentage	Responses	Percentage
Personal Knowledge	13	87%	14	100%	27	93%
Files/Paperwork	10	67%	6	43%	16	55%
Computer Database	3	20%	2	14%	5	17%
Total Number of Responding DRs	15		14		29	

IV. ANALYSIS

A. Survey Response Rate Analysis

The response rate for Phase II increased the overall response rate (based on the number of completed surveys and telephone interviews) for Region III to 85%. This is the highest response

rate for any region in the State. However, it is important to note that responses to the three-question telephone survey are the basis for this increase and other regions of the State were not afforded the opportunity to respond similarly. The Region III response rate is illustrated graphically in Chart A, along with the response rates of the other regions in the State.

Chart A. Response Rate Based on Completed Survey/Telephone Responses

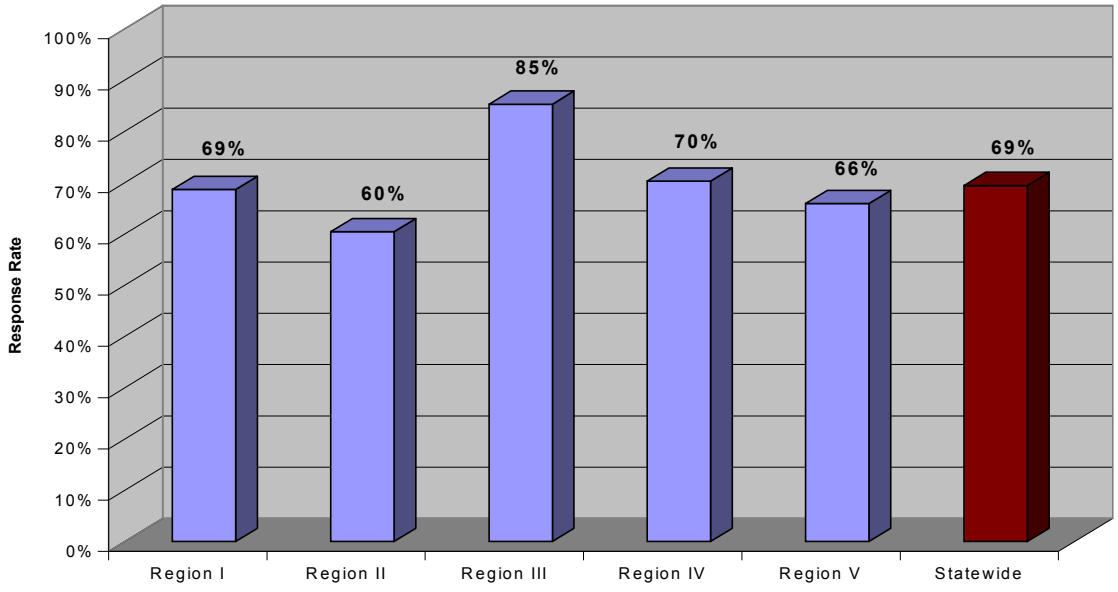
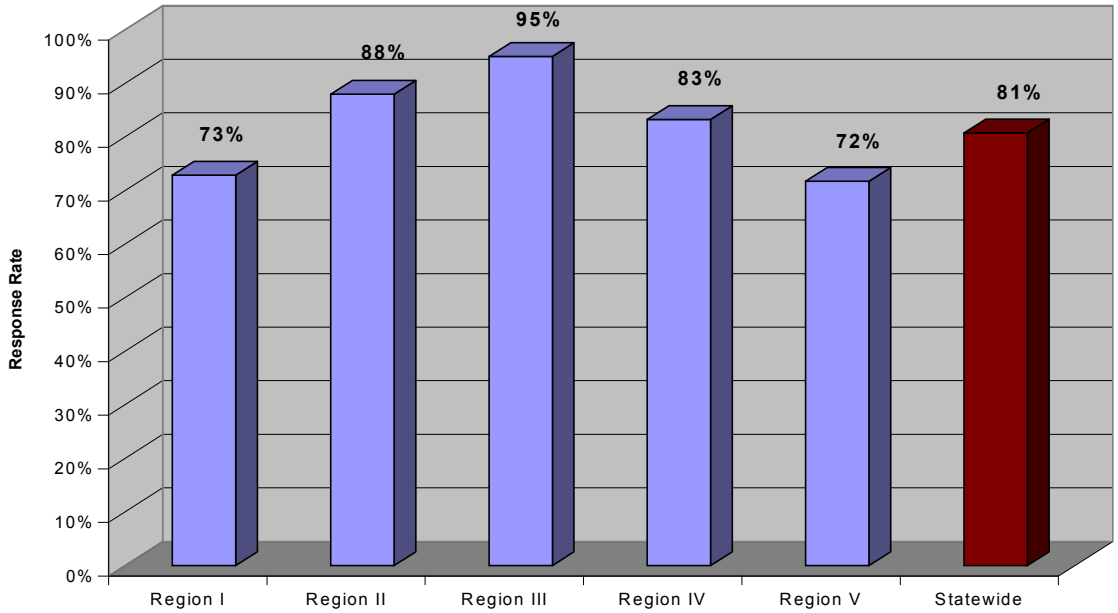


Chart B. Response Rate Based on OSSF Systems Represented by Survey Responses



The response rate for Region III, based on the number of OSSF systems represented by the completed surveys and telephone interviews, is 95%. This represents a significant increase over the 32% response rate in Phase I. The response rate for all regions and statewide, based on the number of OSSF systems represented by survey results, is illustrated in Chart B.

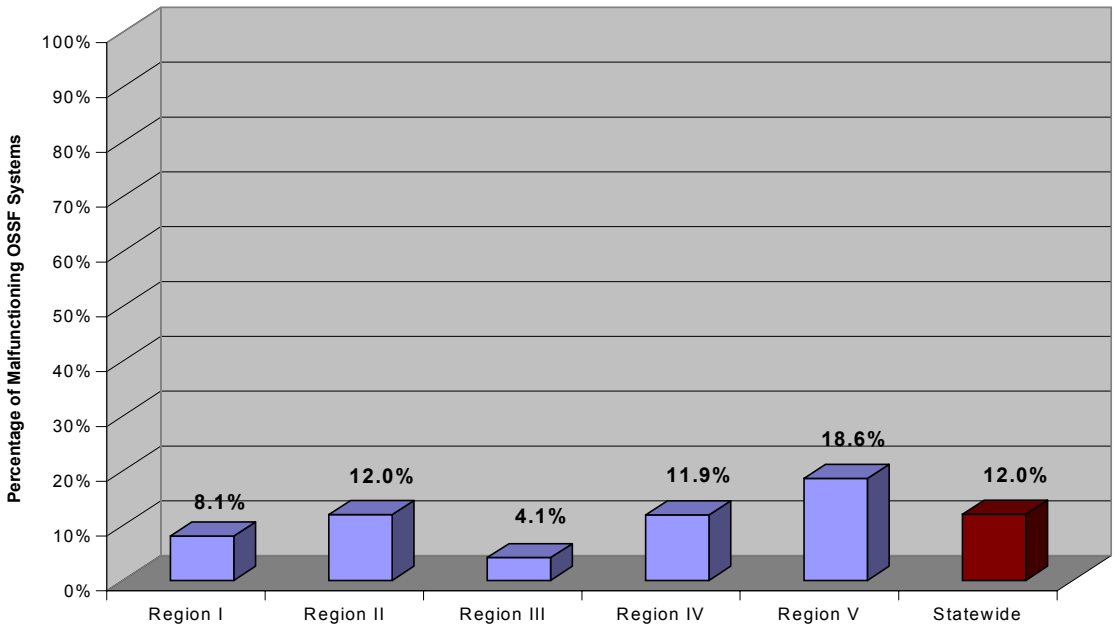
The fact that there is such a significant increase in this measure of the response rate illustrates that the telephone interviews performed during Phase II were successful in reaching the majority of the DRs that have large numbers of OSSF systems within their jurisdictions.

B. Analysis of Chronically Malfunctioning OSSF Systems

The results of the Phase II telephone survey are consistent with the trend established in Phase I of the project. The DRs reported a very low incidence of chronically malfunctioning OSSF systems in Region III. Chart C illustrates the number of chronically malfunctioning OSSF systems in each of the reporting jurisdictions for each region in the State of Texas.

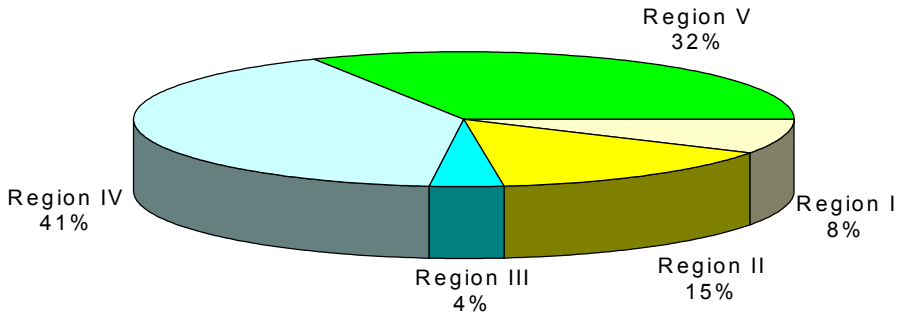
The reported rate of chronically malfunctioning OSSF systems in Region III increased slightly from the results of Phase I. The responses to the telephone surveys increased the overall rate of chronic malfunction from 2.8% to 4.1%. This rate is still lower than the 12% average rate of chronically malfunctioning OSSF systems reported for the State of Texas.

Chart C. Percent of Chronically Malfunctioning OSSF Systems Reported by Region



Another illustration of this reported low incidence of chronically malfunctioning OSSF systems in Region III can be illustrated by showing the number of chronically malfunctioning OSSF systems that are attributed to each region of the State. Chart D illustrates that out of the 152,772 chronically malfunctioning OSSF systems reported in Texas, only 4% are reported to be in Region III.

Chart D. Percent of Total Chronically Malfunctioning OSSF Systems by Region



When appropriate, the project team asked the DRs about their opinion as to the reasons for the low rate of chronic OSSF malfunction in Region III. Several DRs provided additional remarks during phone interviews explaining these relatively low malfunction rates. It is important to note that these additional comments are based on conversations with DRs and do not represent a detailed review or verification of these observations by the project team. The general explanations and observations provided by the DRs regarding this issue include:

- The soil quality in Region III is regarded as "ideal" for effluent absorption.
- Increases in grant funding for wastewater system improvements and upgrades have resulted in transitions from malfunctioning OSSF systems to centralized systems.
- The installation of new OSSF systems has been reduced in some areas due to the availability of connections to centralized sewage system.
- The lack of rain in the Region III allows the soils to more easily absorb OSSF effluent and the high temperatures increase evaporation, resulting in fewer system overflows.

V. CONCLUSION

Based on the information provided by the DRs in Phase II, the project team has determined that Region III is not encountering the same problems with chronically malfunctioning OSSF systems as the other regions of the State. The DRs report the favorable soil and climate conditions to contribute to the proper functioning of OSSF systems. Additionally, the increased availability of centralized water and wastewater infrastructure for areas along the border with Mexico has contributed to the replacement of older existing systems, as well as diminished the need for new installations of OSSF systems.

VI. AMENDED PHASE I DATA

Through the course of reviewing the survey results from Region III, it was discovered that some of the surveys mailed to Designated Representatives in Bexar County were categorized in the incorrect region during Phase I of the project. Bexar County is on the border of Region III and Region IV, but for the purpose of the survey should be categorized as Region II. This change had a relatively insignificant impact on the original survey response rates and does not alter the initial analysis performed in Phase I of the project. The revised data for the other regions of Texas are presented in Appendix B. The impact of this amended data for Region III is presented in Table D below and the complete survey results for Region III are presented in Appendix A.

Table D. Amended Data

Region III Data	Original Data		Amended Data	
	Survey Data	Response Rate	Survey Data	Response Rate
Total number of surveys mailed to DRs in Region III.	36		34	
Response rate based on total number of completed surveys	16	44.4%	15	44.1%
Estimated total OSSF systems in Region III from Census data.	138,291		138,291	
Response rate based on OSSF systems represented by completed surveys.	44,645	32.3%	44,145	31.9%

Because the surveys that were miscategorized for Region III were representative of a very low number of OSSF systems, and because they did not report any malfunctioning OSSF systems within their jurisdiction, the Region III rate of chronic malfunction was only minimally altered. The total reported rate of chronic malfunctioning OSSF systems in Region III, inclusive of the amended data, was increased from 2.79% to 2.82%.

Appendix A

REGION III SURVEY RESULTS

Table III.A: Survey Response Profile

Region 3 Data	Frequency	Percentage
Total number of counties in region.	23	
Total number of surveys mailed to Designated Representatives.	34	
Total number of written surveys returned.	16	47.1%
Total number of written surveys returned and telephone responses.	29	85.3%
Estimated total OSSF systems in Region I from Census data.	138,291	
Response rate based on OSSFs represented by written surveys.	94,921	68.6%
Response rate based on OSSFs represented by written surveys & telephone.	131,447	95.1%

Table III.B: Background Information

Question/Answer	Frequency	Percentage
How long have you been a Designated Representative?		
Less than 1 Year	1	6%
1 to 3 Years	10	63%
More than 3 Years	5	31%
Total Reponse Frequency	**16**	**100%**
Select all sources of information you used to provide answers for this survey.		
Personal Knowledge	27	93%
Files/Paperwork	16	55%
Computer Database	5	17%

Table III.C: Malfunctioning OSSF Systems

Question/Answer	Total	Percentage
Estimated number of chronically malfunctioning OSSF systems based on written survey and telephone response data.	5,446	4.1%

Table III.D: OSSF Systems by Soil Classification

Question/Answer	Total	Percentage
Estimate the percentage by soil category where OSSF systems are most typically installed in your jurisdiction.		
I-a: (sandy-texture soils that contain more than 30% gravel)	89	0.1%
I-b: (sandy soils that contain 30% gravel or less)	5,455	5.7%
II: (coarse loamy soils that include sandy loam and loam textures)	19,397	20.4%
III: (fine loamy soils that include silt, loam, clay, and sand)	65,084	68.6%
IV: (fine-textured soils that contain more than 40% clay-sized particles)	4,895	5.2%
Total OSSFs Installed in Region	**44,645**	**100.0%**

Table III.E: Ranking of Factors in Malfunctioning OSSF Systems

Question/Answer	Average	Mode
Rank the impact that the following categories have on the malfunction of OSSF systems in your jurisdiction. (1= greatest impact; 10= lowest impact)		
Age of the System	3.1	1
Climate	8.6	10
Design	3.9	3
High Water Table	7.5	9
Installation/Construction	4.8	4
Lack of Education/Public Awareness	5.8	6
Operation & Maintenance	4.6	5
Regulations	7.7	10
Small Lot Size and Population Density	4.9	4
Soils	4.1	7

Table III.F: Contributing Factors to the Malfunction of OSSF Systems

Category	Severe		Moderate		Minimal		None	
	Frequency	%	Frequency	%	Frequency	%	Frequency	%
Climate	0	0%	1	6%	7	44%	7	44%
High Water Table	0	0%	4	25%	7	44%	4	25%
Improper Installation/Construction	6	38%	3	19%	5	31%	1	6%
Improper Operation & Maintenance	3	19%	6	38%	5	31%	1	6%
Improper System Design	6	38%	3	19%	5	31%	1	6%
Lack of Education for OSSF Owners	2	13%	7	44%	4	25%	1	6%
Lack of Training for Designated Representatives	0	0%	3	19%	7	44%	5	31%
Lack of Training for Designers	2	13%	3	19%	7	44%	3	19%
Lack of Training for Installers	3	19%	5	31%	4	25%	3	19%
Pre-regulatory "Grandfathered" Systems	8	50%	5	31%	2	13%	0	0%
Small Lot Size	3	19%	9	56%	2	13%	1	6%
Soils	2	13%	7	44%	5	31%	1	6%

Table III.G: Effects of Soil, Design, Climate and Operation/Maintenance on OSSF Systems

Category	Severe		Moderate		Minimal/None	
	Frequency	%	Frequency	%	Frequency	%
A. Soil						
Tightly-packed clay soils do not allow proper leaching.	5	31%	2	13%	9	56%
Rocky soils allow sewage to drain too quickly through the system.	1	6%	3	19%	12	75%
Fractured limestone soils allow sewage to flow directly into the ground.	0	0%	2	13%	14	88%
Solid rock subsurface makes it difficult to construct an adequate drainfield.	1	6%	2	13%	13	81%
Soils are too naturally saturated to absorb effluent. (marshy/high water table).	0	0%	4	25%	12	75%
B. Design						
Improper classification of soil type.	4	25%	2	13%	10	63%
OSSF system is not appropriate for the soil type and/or climate.	5	31%	2	13%	9	56%
Drainfield is too close to traffic areas, resulting in damage from vehicles.	2	13%	1	6%	13	81%
Location of drainfield causes drainage problems due to topography.	2	13%	2	13%	12	75%
OSSF system is too small for the sewage load from the facility.	5	31%	4	25%	7	44%
OSSF system is too small for the sewage strength from the facility.	3	19%	1	6%	12	75%
Water runoff from rooftops, patios and driveways is not properly diverted.	0	0%	3	19%	13	81%
The lot size and/or drainfield is too small.	6	38%	2	13%	8	50%
C. Climate						
Flooding… Systems are located in a floodplain.	1	6%	0	0%	15	94%
Frequent rainfall causes ground saturation.	0	0%	2	13%	14	88%
Cold winters cause soils to freeze.	0	0%	1	6%	15	94%
Increased rainfall and less evaporation during winter months.	1	6%	1	6%	14	88%
D. Operation and Maintenance						
OSSF systems or parts are worn out or damaged and not replaced.	2	13%	4	25%	10	63%
OSSF system is not pumped as often as necessary.	2	13%	6	38%	8	50%
Improper disposal of solvents, grease, and other substances into OSSF.	1	6%	6	38%	9	56%
Residents fail to renew their maintenance contracts.	0	0%	2	13%	14	88%
Required disinfectant is either incorrectly added or not added to OSSF.	2	13%	0	0%	14	88%
Roots from trees or shrubs are interfering with drainfield lines.	0	0%	7	44%	9	56%
Driving over drainfields with vehicles.	2	13%	1	6%	13	81%
Paving over or constructing facilities on drainfield.	1	6%	2	13%	13	81%

Table III.H: Functionality of Different Types of OSSF Systems

Types of OSSF Systems	Function Well	%	Function Poorly	%
Absorptive Mounds	1	6%	0	0%
Drip Emitters	1	6%	0	0%
Evapotranspiration Beds	5	31%	1	6%
Graveless Pipe	9	56%	2	13%
Leaching Chambers	9	56%	0	0%
Low Pressure Dosing	5	31%	0	0%
Standard Trenches/Beds	13	81%	0	0%
Surface Irrigation	6	38%	0	0%

Table III.I: Functionality of Different Treatment Technologies

Types of Treatment Technology	Function Well	%
Aerobic Systems	5	31%
Sand Filters	0	0%
Trickling Filters	0	0%
Constructed Wetlands	1	6%
Septic Tanks	12	75%

Table III.J: 1997 Rule Changes

Survey Opinions	Frequency	%
Strongly Agree	2	13%
Agree	9	56%
Neutral	4	25%
Disagree	1	6%
Strongly Disagree	0	0%

Table III.K: Owner Education and Designated Representative Training

Question/Answer	Yes	%	No	%
In your opinion, do owners of OSSF systems receive sufficient information to have a funamental undertanding of how to properly care for and operate their OSSF System?	8	50%	8	50%
Do you believe that you are receiving adequate training from the TNRCC regarding the resopnsibiliites and duties of a Designated Representative?	15	94%	1	6%

Appendix B

REGION I SURVEY RESULTS

Table I.A: Survey Response Profile

Region 1 Data	Frequency	Percentage
Total number of counties in region.	86	
Total number of surveys mailed to Designated Representatives.	51	
Response rate based on total number of completed surveys.	35	69%
Estimated total OSSF systems in Region I from Census data.	218,100	
Response rate based on OSSF systems represented by completed surveys.	158,997	73%

Table I.B: Background Information

Question/Answer	Frequency	Percentage
How long have you been a Designated Representative?		
Less than 1 Year	3	9%
1 to 3 Years	8	23%
More than 3 Years	24	69%
Total Reponse Frequency	**35**	**100%**
Select all sources of information you used to provide answers for this survey.		
Personal Knowledge	31	89%
Files/Paperwork	32	91%
Computer Database	14	40%

Table I.C: Malfunctioning OSSF Systems

Question/Answer	Total	Percentage
Estimated number of chronically malfunctioning OSSF systems based on survey response data.	12,876	8.1%

Table I.D: OSSF Systems by Soil Classification

Question/Answer	Total	Percentage
Estimate the percentage by soil category where OSSF systems are most typically installed in your jurisdiction.		
I-a: (sandy-texture soils that contain more than 30% gravel)	15,863	10%
I-b: (sandy soils that contain 30% gravel or less)	18,456	12%
II: (coarse loamy soils that include sandy loam and loam textures)	49,424	31%
III: (fine loamy soils that include silt, loam, clay, and sand)	59,103	37%
IV: (fine-textured soils that contain more than 40% clay-sized particles)	16,132	10%
Total OSSFs Installed in Region	**158,978**	**100%**

Table I.E: Ranking of Factors in Malfunctioning OSSF Systems

Question/Answer	Average	Mode
Rank the impact that the following categories have on the malfunction of OSSF systems in your jurisdiction. (1= greatest impact; 10= lowest impact)		
Age of the System	2.2	1
Climate	8.0	9
Design	5.5	6
High Water Table	8.8	10
Installation/Construction	5.6	6
Lack of Education/Public Awareness	4.2	3
Operation & Maintenance	3.2	1
Regulations	6.9	10
Small Lot Size and Population Density	5.8	6
Soils	4.8	5

Table I.F: Contributing Factors to the Malfunction of OSSF Systems

Category	Severe		Moderate		Minimal		None	
	Frequency	%	Frequency	%	Frequency	%	Frequency	%
Climate	1	3%	2	6%	18	51%	14	40%
High Water Table	1	3%	3	9%	16	46%	15	43%
Improper Installation/Construction	3	9%	17	49%	12	34%	3	9%
Improper Operation & Maintenance	12	34%	12	34%	9	26%	2	6%
Improper System Design	2	6%	14	40%	14	40%	5	14%
Lack of Education for OSSF Owners	13	37%	11	31%	6	17%	3	9%
Lack of Training for Designated Representatives	1	3%	4	11%	13	37%	17	49%
Lack of Training for Designers	4	11%	3	9%	15	43%	13	37%
Lack of Training for Installers	1	3%	10	29%	14	40%	10	29%
Pre-regulatory "Grandfathered" Systems	18	51%	10	29%	3	9%	3	9%
Small Lot Size	6	17%	15	43%	10	29%	4	11%
Soils	6	17%	12	34%	12	34%	5	14%

Table I.G: Effects of Soil, Design, Climate and Operation/Maintenance on OSSF Systems

Category	Severe		Moderate		Minimal/None	
	Frequency	%	Frequency	%	Frequency	%
A. Soil						
Tightly-packed clay soils do not allow proper leaching.	4	11%	12	34%	19	54%
Rocky soils allow sewage to drain too quickly through the system.	1	3%	8	23%	26	74%
Fractured limestone soils allow sewage to flow directly into the ground.	1	3%	8	23%	26	74%
Solid rock subsurface makes it difficult to construct an adequate drainfield.	5	14%	9	26%	21	60%
Soils are too naturally saturated to absorb effluent. (marshy/high water table).	1	3%	7	20%	27	77%
B. Design						
Improper classification of soil type.	1	3%	12	34%	22	63%
OSSF system is not appropriate for the soil type and/or climate.	0	0%	9	26%	26	74%
Drainfield is too close to traffic areas, resulting in damage from vehicles.	0	0%	10	29%	25	71%
Location of drainfield causes drainage problems due to topography.	2	6%	4	11%	29	83%
OSSF system is too small for the sewage load from the facility.	5	14%	4	11%	26	74%
OSSF system is too small for the sewage strength from the facility.	3	9%	4	11%	28	80%
Water runoff from rooftops, patios and driveways is not properly diverted.	1	3%	3	9%	31	89%
The lot size and/or drainfield is too small.	5	14%	9	26%	21	60%
C. Climate						
Flooding… Systems are located in a floodplain.	0	0%	4	11%	31	89%
Frequent rainfall causes ground saturation.	0	0%	3	9%	32	91%
Cold winters cause soils to freeze.	0	0%	2	6%	33	94%
Increased rainfall and less evaporation during winter months.	1	3%	5	14%	29	83%
D. Operation and Maintenance						
OSSF systems or parts are worn out or damaged and not replaced.	2	6%	8	23%	25	71%
OSSF system is not pumped as often as necessary.	7	20%	11	31%	17	49%
Improper disposal of solvents, grease, and other substances into OSSF.	2	6%	12	34%	21	60%
Residents fail to renew their maintenance contracts.	4	11%	3	9%	28	80%
Required disinfectant is either incorrectly added or not added to OSSF.	4	11%	5	14%	26	74%
Roots from trees or shrubs are interfering with drainfield lines.	2	6%	12	34%	21	60%
Driving over drainfields with vehicles.	1	3%	10	29%	24	69%
Paving over or constructing facilities on drainfield.	0	0%	10	29%	25	71%

Table I.H: Functionality of Different Types of OSSF Systems

Types of OSSF Systems	Function Well	%	Function Poorly	%
Absorptive Mounds	7	20%	0	0%
Drip Emitters	6	17%	0	0%
Evapotranspiration Beds	13	37%	2	6%
Graveless Pipe	12	34%	5	14%
Leaching Chambers	29	83%	1	3%
Low Pressure Dosing	10	29%	0	0%
Standard Trenches/Beds	26	74%	2	6%
Surface Irrigation	11	31%	3	9%

Table I.I: Functionality of Different Treatment Technologies

Types of Treatment Technology	Function Well	%
Aerobic Systems	18	51%
Sand Filters	3	9%
Trickling Filters	0	0%
Constructed Wetlands	0	0%
Septic Tanks	33	94%

Table I.J: 1997 Rule Changes

Survey Opinions	Frequency	%
Strongly Agree	9	26%
Agree	14	40%
Neutral	10	29%
Disagree	1	3%
Strongly Disagree	1	3%

Table I.K: Owner Education and Designated Representative Training

Question/Answer	Yes	%	No	%
In your opinion, do owners of OSSF systems receive sufficient information to have a funamental undertanding of how to properly care for and operate their OSSF System?	14	40%	21	60%
Do you believe that you are receiving adequate training from the TNRCC regarding the resopnsibiliites and duties of a Designated Representative?	28	80%	7	20%

REGION II SURVEY RESULTS

Table II.A: Survey Response Profile

Region 2 Data	Frequency	Percentage
Total number of counties in region.	44	
Total number of surveys mailed to Designated Representatives.	48	
Response rate based on total number of completed surveys.	29	60.4%
Estimated total OSSF systems in Region II from Census data.	211,797	
Response rate based on OSSF systems represented by completed surveys.	186,281	88.0%

Table II.B: Background Information

Question/Answer	Frequency	Percentage
How long have you been a Designated Representative?		
Less than 1 Year	5	17%
1 to 3 Years	7	24%
More than 3 Years	17	59%
Total Reponse Frequency	**29**	**100%**
Select all sources of information you used to provide answers for this survey.		
Personal Knowledge	27	93%
Files/Paperwork	23	79%
Computer Database	15	52%

Table II.C: Malfunctioning OSSF Systems

Question/Answer	Total	Percentage
Estimated number of chronically malfunctioning OSSF systems based on written survey and telephone response data.	22,296	12.0%

Table II.D: OSSF Systems by Soil Classification

Question/Answer	Total	Percentage
Estimate the percentage by soil category where OSSF systems are most typically installed in your jurisdiction.		
I-a: (sandy-texture soils that contain more than 30% gravel)	10,479	5.6%
I-b: (sandy soils that contain 30% gravel or less)	21,503	11.5%
II: (coarse loamy soils that include sandy loam and loam textures)	30,573	16.4%
III: (fine loamy soils that include silt, loam, clay, and sand)	80,547	43.2%
IV: (fine-textured soils that contain more than 40% clay-sized particles)	38,653	20.8%
Total OSSFs Installed in Region	**181,755**	**97.6%**

Table II.E: Ranking of Factors in Malfunctioning OSSF Systems

Question/Answer	Average	Mode
Rank the impact that the following categories have on the malfunction of OSSF systems in your jurisdiction. (1= greatest impact; 10= lowest impact)		
Age of the System	2.7	1
Climate	6.9	6
Design	5.6	4
High Water Table	7.4	10
Installation/Construction	5.5	5
Lack of Education/Public Awareness	5.4	6
Operation & Maintenance	4.1	1
Regulations	8.1	10
Small Lot Size and Population Density	4.1	1
Soils	5.3	3

Table II.F: Contributing Factors to the Malfunction of OSSF Systems

Category	Severe		Moderate		Minimal		None	
	Frequency	%	Frequency	%	Frequency	%	Frequency	%
Climate	0	0%	5	17%	11	38%	10	34%
High Water Table	2	7%	4	14%	8	28%	12	41%
Improper Installation/Construction	1	3%	10	34%	13	45%	2	7%
Improper Operation & Maintenance	5	17%	14	48%	4	14%	3	10%
Improper System Design	0	0%	11	38%	8	28%	5	17%
Lack of Education for OSSF Owners	5	17%	10	34%	9	31%	2	7%
Lack of Training for Designated Representatives	0	0%	2	7%	10	34%	14	48%
Lack of Training for Designers	0	0%	4	14%	15	52%	7	24%
Lack of Training for Installers	0	0%	3	10%	16	55%	7	24%
Pre-regulatory "Grandfathered" Systems	6	21%	11	38%	6	21%	2	7%
Small Lot Size	5	17%	5	17%	11	38%	5	17%
Soils	4	14%	9	31%	9	31%	4	14%

Table II.G: Effects of Soil, Design, Climate and Operation/Maintenance on OSSF Systems

Category	Severe		Moderate		Minimal/None	
	Frequency	%	Frequency	%	Frequency	%
A. Soil						
Tightly-packed clay soils do not allow proper leaching.	6	21%	6	21%	17	59%
Rocky soils allow sewage to drain too quickly through the system.	2	7%	10	34%	17	59%
Fractured limestone soils allow sewage to flow directly into the ground.	6	21%	5	17%	18	62%
Solid rock subsurface makes it difficult to construct an adequate drainfield.	4	14%	6	21%	19	66%
Soils are too naturally saturated to absorb effluent. (marshy/high water table).	2	7%	5	17%	22	76%
B. Design						
Improper classification of soil type.	1	3%	10	34%	18	62%
OSSF system is not appropriate for the soil type and/or climate.	1	3%	9	31%	19	66%
Drainfield is too close to traffic areas, resulting in damage from vehicles.	1	3%	6	21%	22	76%
Location of drainfield causes drainage problems due to topography.	2	7%	6	21%	21	72%
OSSF system is too small for the sewage load from the facility.	2	7%	13	45%	14	48%
OSSF system is too small for the sewage strength from the facility.	1	3%	5	17%	23	79%
Water runoff from rooftops, patios and driveways is not properly diverted.	1	3%	6	21%	22	76%
The lot size and/or drainfield is too small.	3	10%	11	38%	15	52%
C. Climate						
Flooding… Systems are located in a floodplain.	0	0%	3	10%	26	90%
Frequent rainfall causes ground saturation.	0	0%	9	31%	20	69%
Cold winters cause soils to freeze.	0	0%	2	7%	27	93%
Increased rainfall and less evaporation during winter months.	2	7%	7	24%	20	69%
D. Operation and Maintenance						
OSSF systems or parts are worn out or damaged and not replaced.	2	7%	8	28%	19	66%
OSSF system is not pumped as often as necessary.	6	21%	12	41%	11	38%
Improper disposal of solvents, grease, and other substances into OSSF.	3	10%	9	31%	17	59%
Residents fail to renew their maintenance contracts.	2	7%	9	31%	18	62%
Required disinfectant is either incorrectly added or not added to OSSF.	4	14%	6	21%	19	66%
Roots from trees or shrubs are interfering with drainfield lines.	4	14%	13	45%	12	41%
Driving over drainfields with vehicles.	4	14%	9	31%	16	55%
Paving over or constructing facilities on drainfield.	2	7%	7	24%	20	69%

Table II.H: Functionality of Different Types of OSSF Systems

Types of OSSF Systems	Function Well	%	Function Poorly	%
Absorptive Mounds	8	28%	1	3%
Drip Emitters	8	28%	0	0%
Evapotranspiration Beds	9	31%	2	7%
Graveless Pipe	10	34%	2	7%
Leaching Chambers	18	62%	0	0%
Low Pressure Dosing	15	52%	1	3%
Standard Trenches/Beds	19	66%	0	0%
Surface Irrigation	13	45%	4	14%

Table II.I: Functionality of Different Treatment Technologies

Types of Treatment Technology	Function Well	%
Aerobic Systems	14	48%
Sand Filters	4	14%
Trickling Filters	2	7%
Constructed Wetlands	0	0%
Septic Tanks	25	86%

Table II.J: 1997 Rule Changes

Survey Opinions	Frequency	%
Strongly Agree	7	24%
Agree	15	52%
Neutral	4	14%
Disagree	2	7%
Strongly Disagree	1	3%

Table II.K: Owner Education and Designated Representative Training

Question/Answer	Yes	%	No	%
In your opinion, do owners of OSSF systems receive sufficient information to have a funamental undertanding of how to properly care for and operate their OSSF System?	10	34%	19	66%
Do you believe that you are receiving adequate training from the TNRCC regarding the resopnsibiliites and duties of a Designated Representative?	27	93%	2	7%

REGION IV SURVEY RESULTS

Table IV.A: Survey Response Profile

Region 4 Data	Frequency	Percentage
Total number of counties in region.	67	
Total number of surveys mailed to Designated Representatives.	101	
Total number of completed surveys returned.	71	70%
Estimated total OSSF systems in Region I from Census data.	629,028	
Response rate based on OSSF systems represented by completed surveys.	523,801	83%

Table IV.B: Background Information

Question/Answer	Frequency	Percentage
How long have you been a Designated Representative?		
Less than 1 Year	7	10%
1 to 3 Years	13	18%
More than 3 Years	51	72%
Total Reponse Frequency	**71**	**100%**
Select all sources of information you used to provide answers for this survey.		
Personal Knowledge	67	94%
Files/Paperwork	67	94%
Computer Database	36	51%

Table IV.C: Malfunctioning OSSF Systems

Question/Answer	Total	Percentage
Estimated number of chronically malfunctioning OSSF systems based on survey response data.	62,513	11.9%

Table IV.D: OSSF Systems by Soil Classification

Question/Answer	Total	Percentage
Estimate the percentage by soil category where OSSF systems are most typically installed in your jurisdiction.		
I-a: (sandy-texture soils that contain more than 30% gravel)	23,506	4.5%
I-b: (sandy soils that contain 30% gravel or less)	33,024	6.3%
II: (coarse loamy soils that include sandy loam and loam textures)	54,861	10.5%
III: (fine loamy soils that include silt, loam, clay, and sand)	109,778	21.0%
IV: (fine-textured soils that contain more than 40% clay-sized particles)	251,145	47.9%
Total Reported OSSFs Installed in Region	**472,314**	**90.2%**

Table IV.E: Ranking of Factors in Malfunctioning OSSF Systems

Question/Answer	Average	Mode
Rank the impact that the following categories have on the malfunction of OSSF systems in your jurisdiction. (1= greatest impact; 10= lowest impact)		
Age of the System	3.5	1
Climate	5.6	2
Design	5.3	4
High Water Table	6.3	9
Installation/Construction	5.8	5
Lack of Education/Public Awareness	5.6	6
Operation & Maintenance	5.0	5
Regulations	8.6	10
Small Lot Size and Population Density	6.2	9
Soils	2.9	1

Table IV.F: Contributing Factors to the Malfunction of OSSF Systems

Category	Severe		Moderate		Minimal		None	
	Frequency	%	Frequency	%	Frequency	%	Frequency	%
Climate	7	10%	28	39%	27	38%	5	7%
High Water Table	5	7%	22	31%	30	42%	11	15%
Improper Installation/Construction	4	6%	25	35%	35	49%	3	4%
Improper Operation & Maintenance	11	15%	36	51%	17	24%	3	4%
Improper System Design	8	11%	21	30%	30	42%	9	13%
Lack of Education for OSSF Owners	20	28%	32	45%	15	21%	0	0%
Lack of Training for Designated Representatives	1	1%	5	7%	34	48%	28	39%
Lack of Training for Designers	2	3%	19	27%	30	42%	17	24%
Lack of Training for Installers	2	3%	18	25%	37	52%	11	15%
Pre-regulatory "Grandfathered" Systems	33	46%	22	31%	10	14%	3	4%
Small Lot Size	21	30%	19	27%	20	28%	8	11%
Soils	30	42%	26	37%	9	13%	3	4%

Table IV.G: Effects of Soil, Design, Climate and Operation/Maintenance on OSSF Systems

Category	Severe		Moderate		Minimal/None	
	Frequency	%	Frequency	%	Frequency	%
A. Soil						
Tightly-packed clay soils do not allow proper leaching.	37	52%	16	23%	18	25%
Rocky soils allow sewage to drain too quickly through the system.	2	3%	20	28%	49	69%
Fractured limestone soils allow sewage to flow directly into the ground.	1	1%	19	27%	51	72%
Solid rock subsurface makes it difficult to construct an adequate drainfield.	6	8%	15	21%	50	70%
Soils are too naturally saturated to absorb effluent. (marshy/high water table).	11	15%	26	37%	34	48%
B. Design						
Improper classification of soil type.	6	8%	29	41%	36	51%
OSSF system is not appropriate for the soil type and/or climate.	16	23%	26	37%	29	41%
Drainfield is too close to traffic areas, resulting in damage from vehicles.	1	1%	22	31%	48	68%
Location of drainfield causes drainage problems due to topography.	6	8%	31	44%	34	48%
OSSF system is too small for the sewage load from the facility.	14	20%	29	41%	28	39%
OSSF system is too small for the sewage strength from the facility.	5	7%	25	35%	41	58%
Water runoff from rooftops, patios and driveways is not properly diverted.	9	13%	22	31%	40	56%
The lot size and/or drainfield is too small.	20	28%	22	31%	29	41%
C. Climate						
Flooding… Systems are located in a floodplain.	3	4%	21	30%	47	66%
Frequent rainfall causes ground saturation.	16	23%	26	37%	29	41%
Cold winters cause soils to freeze.	0	0%	10	14%	61	86%
Increased rainfall and less evaporation during winter months.	20	28%	23	32%	28	39%
D. Operation and Maintenance						
OSSF systems or parts are worn out or damaged and not replaced.	9	13%	33	46%	29	41%
OSSF system is not pumped as often as necessary.	17	24%	33	46%	21	30%
Improper disposal of solvents, grease, and other substances into OSSF.	7	10%	33	46%	31	44%
Residents fail to renew their maintenance contracts.	20	28%	22	31%	29	41%
Required disinfectant is either incorrectly added or not added to OSSF.	19	27%	28	39%	24	34%
Roots from trees or shrubs are interfering with drainfield lines.	4	6%	35	49%	32	45%
Driving over drainfields with vehicles.	3	4%	29	41%	39	55%
Paving over or constructing facilities on drainfield.	4	6%	27	38%	40	56%

Table IV.H: Functionality of Different Types of OSSF Systems

Types of OSSF Systems	Function Well	%	Function Poorly	%
Absorptive Mounds	10	14%	3	4%
Drip Emitters	23	32%	4	6%
Evapotranspiration Beds	19	27%	19	27%
Graveless Pipe	13	18%	14	20%
Leaching Chambers	25	35%	12	17%
Low Pressure Dosing	38	54%	8	11%
Standard Trenches/Beds	33	46%	16	23%
Surface Irrigation	55	77%	4	6%

Table IV.I: Functionality of Different Treatment Technologies

Types of Treatment Technology	Function Well	%
Aerobic Systems	65	92%
Sand Filters	9	13%
Trickling Filters	2	3%
Constructed Wetlands	8	11%
Septic Tanks	47	66%

Table IV.J: 1997 Rule Changes

Survey Opinions	Frequency	%
Strongly Agree	18	25%
Agree	37	52%
Neutral	11	15%
Disagree	2	3%
Strongly Disagree	3	4%

Table IV.K: Owner Education and Designated Representative Training

Question/Answer	Yes	%	No	%
In your opinion, do owners of OSSF systems receive sufficient information to have a funamental undertanding of how to properly care for and operate their OSSF System?	11	15%	60	85%
Do you believe that you are receiving adequate training from the TNRCC regarding the resopnsibiliites and duties of a Designated Representative?	53	75%	18	25%

REGION V SURVEY RESULTS

Table V.A: Survey Response Profile

Region 5 Data	Frequency	Percentage
Total number of counties in region.	34	
Total number of surveys mailed to Designated Representatives.	44	
Total number of completed surveys returned.	29	66%
Estimated total OSSF systems in Region I from Census data.	372,726	
Response rate based on OSSF systems represented by completed surveys.	267,397	72%

Table V.B: Background Information

Question/Answer	Frequency	Percentage
How long have you been a Designated Representative?		
Less than 1 Year	3	10%
1 to 3 Years	7	24%
More than 3 Years	19	66%
Total Reponse Frequency	**29**	**100%**
Select all sources of information you used to provide answers for this survey.		
Personal Knowledge	28	97%
Files/Paperwork	28	97%
Computer Database	17	59%

Table V.C: Malfunctioning OSSF Systems

Question/Answer	Total	Percentage
Estimated number of chronically malfunctioning OSSF systems based on survey response data.	49,641	18.6%

Table V.D: OSSF Systems by Soil Classification

Question/Answer	Total	Percentage
Estimate the percentage by soil category where OSSF systems are most typically installed in your jurisdiction.		
I-a: (sandy-texture soils that contain more than 30% gravel)	3,544	1.3%
I-b: (sandy soils that contain 30% gravel or less)	11,463	4.3%
II: (coarse loamy soils that include sandy loam and loam textures)	37,534	14.0%
III: (fine loamy soils that include silt, loam, clay, and sand)	71,690	26.8%
IV: (fine-textured soils that contain more than 40% clay-sized particles)	143,275	53.6%
Total OSSFs Installed in Region	**267,397**	**100.0%**

Table V.E: Ranking of Factors in Malfunctioning OSSF Systems

Question/Answer	Average	Mode
Rank the impact that the following categories have on the malfunction of OSSF systems in your jurisdiction. (1= greatest impact; 10= lowest impact)		
Age of the System	4.3	4
Climate	4.8	8
Design	6.4	9
High Water Table	4.2	3
Installation/Construction	7.2	8
Lack of Education/Public Awareness	5.9	7
Operation & Maintenance	5.9	6
Regulations	8.6	10
Small Lot Size and Population Density	5.1	2
Soils	2.6	1

Table V.F: Contributing Factors to the Malfunction of OSSF Systems

Category	Severe		Moderate		Minimal		None	
	Frequency	%	Frequency	%	Frequency	%	Frequency	%
Climate	6	21%	14	48%	7	24%	2	7%
High Water Table	10	34%	9	31%	8	28%	1	3%
Improper Installation/Construction	2	7%	9	31%	16	55%	1	3%
Improper Operation & Maintenance	1	3%	17	59%	8	28%	3	10%
Improper System Design	5	17%	8	28%	13	45%	3	10%
Lack of Education for OSSF Owners	10	34%	13	45%	5	17%	1	3%
Lack of Training for Designated Representatives	1	3%	2	7%	15	52%	11	38%
Lack of Training for Designers	1	3%	4	14%	17	59%	7	24%
Lack of Training for Installers	1	3%	5	17%	17	59%	6	21%
Pre-regulatory "Grandfathered" Systems	16	55%	9	31%	3	10%	1	3%
Small Lot Size	10	34%	9	31%	8	28%	2	7%
Soils	19	66%	4	14%	5	17%	1	3%

Table V.G: Effects of Soil, Design, Climate and Operation/Maintenance on OSSF Systems

Category	Severe		Moderate		Minimal/None	
	Frequency	%	Frequency	%	Frequency	%
A. Soil						
Tightly-packed clay soils do not allow proper leaching.	20	69%	7	24%	2	7%
Rocky soils allow sewage to drain too quickly through the system.	1	3%	4	14%	24	83%
Fractured limestone soils allow sewage to flow directly into the ground.	1	3%	2	7%	26	90%
Solid rock subsurface makes it difficult to construct an adequate drainfield.	0	0%	4	14%	25	86%
Soils are too naturally saturated to absorb effluent. (marshy/high water table).	10	34%	10	34%	9	31%
B. Design						
Improper classification of soil type.	3	10%	12	41%	14	48%
OSSF system is not appropriate for the soil type and/or climate.	9	31%	12	41%	8	28%
Drainfield is too close to traffic areas, resulting in damage from vehicles.	0	0%	8	28%	21	72%
Location of drainfield causes drainage problems due to topography.	1	3%	12	41%	16	55%
OSSF system is too small for the sewage load from the facility.	6	21%	12	41%	11	38%
OSSF system is too small for the sewage strength from the facility.	1	3%	12	41%	16	55%
Water runoff from rooftops, patios and driveways is not properly diverted.	3	10%	7	24%	19	66%
The lot size and/or drainfield is too small.	6	21%	13	45%	10	34%
C. Climate						
Flooding… Systems are located in a floodplain.	1	3%	9	31%	19	66%
Frequent rainfall causes ground saturation.	13	45%	11	38%	5	17%
Cold winters cause soils to freeze.	0	0%	5	17%	24	83%
Increased rainfall and less evaporation during winter months.	10	34%	12	41%	7	24%
D. Operation and Maintenance						
OSSF systems or parts are worn out or damaged and not replaced.	1	3%	18	62%	10	34%
OSSF system is not pumped as often as necessary.	4	14%	17	59%	8	28%
Improper disposal of solvents, grease, and other substances into OSSF.	1	3%	13	45%	15	52%
Residents fail to renew their maintenance contracts.	14	48%	13	45%	2	7%
Required disinfectant is either incorrectly added or not added to OSSF.	11	38%	13	45%	5	17%
Roots from trees or shrubs are interfering with drainfield lines.	6	21%	14	48%	9	31%
Driving over drainfields with vehicles.	0	0%	8	28%	21	72%
Paving over or constructing facilities on drainfield.	0	0%	9	31%	20	69%

Table V.H: Functionality of Different Types of OSSF Systems

Types of OSSF Systems	Function Well	%	Function Poorly	%
Absorptive Mounds	1	3%	2	7%
Drip Emitters	10	34%	1	3%
Evapotranspiration Beds	2	7%	6	21%
Graveless Pipe	7	24%	17	59%
Leaching Chambers	14	48%	4	14%
Low Pressure Dosing	10	34%	2	7%
Standard Trenches/Beds	13	45%	10	34%
Surface Irrigation	27	93%	1	3%

Table V.I: Functionality of Different Treatment Technologies

Types of Treatment Technology	Function Well	%
Aerobic Systems	29	100%
Sand Filters	2	7%
Trickling Filters	2	7%
Constructed Wetlands	6	21%
Septic Tanks	19	66%

Table V.J: 1997 Rule Changes

Survey Opinions	Frequency	%
Strongly Agree	9	31%
Agree	14	48%
Neutral	4	14%
Disagree	0	0%
Strongly Disagree	2	7%

Table V.K: Owner Education and Designated Representative Training

Question/Answer	Yes	%	No	%
In your opinion, do owners of OSSF systems receive sufficient information to have a funamental undertanding of how to properly care for and operate their OSSF System?	6	21%	23	79%
Do you believe that you are receiving adequate training from the TNRCC regarding the resopnsibiliites and duties of a Designated Representative?	17	59%	12	41%